A new approach to water content measurements in soil core using microwave probing

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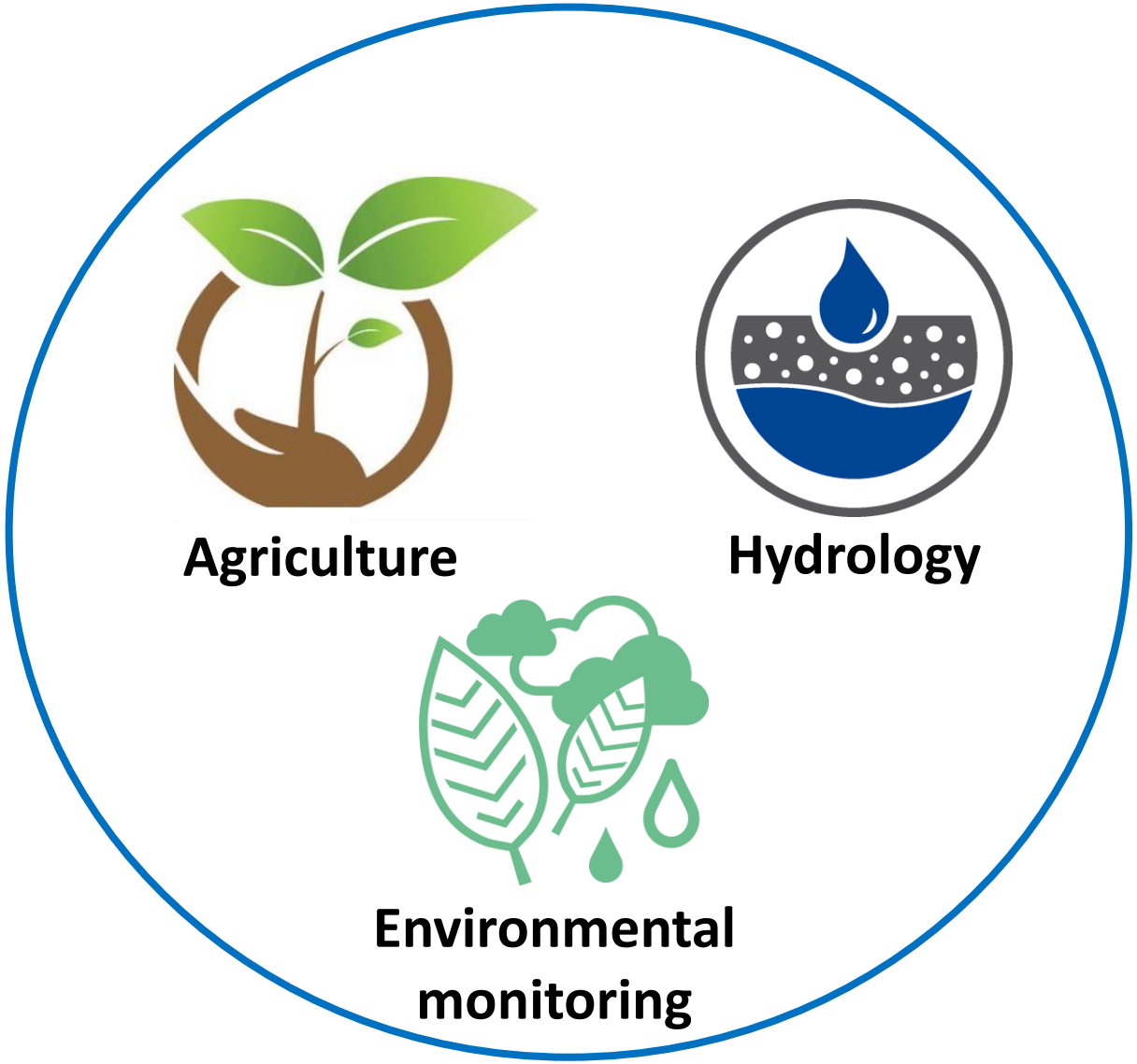
Floriane SPARMA,

Agnieszka SZYPŁOWSKA and Pierre SABOUROUX

Context for soils analysis



Diagnosis of water content in soils

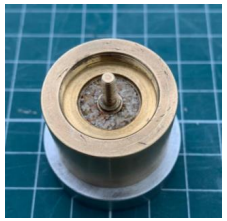
Microwave domain

Field moisture measurement:

- **On Ground Penetrating Radar** → Only subsurface
- **TDR Probes** → Only in first cm

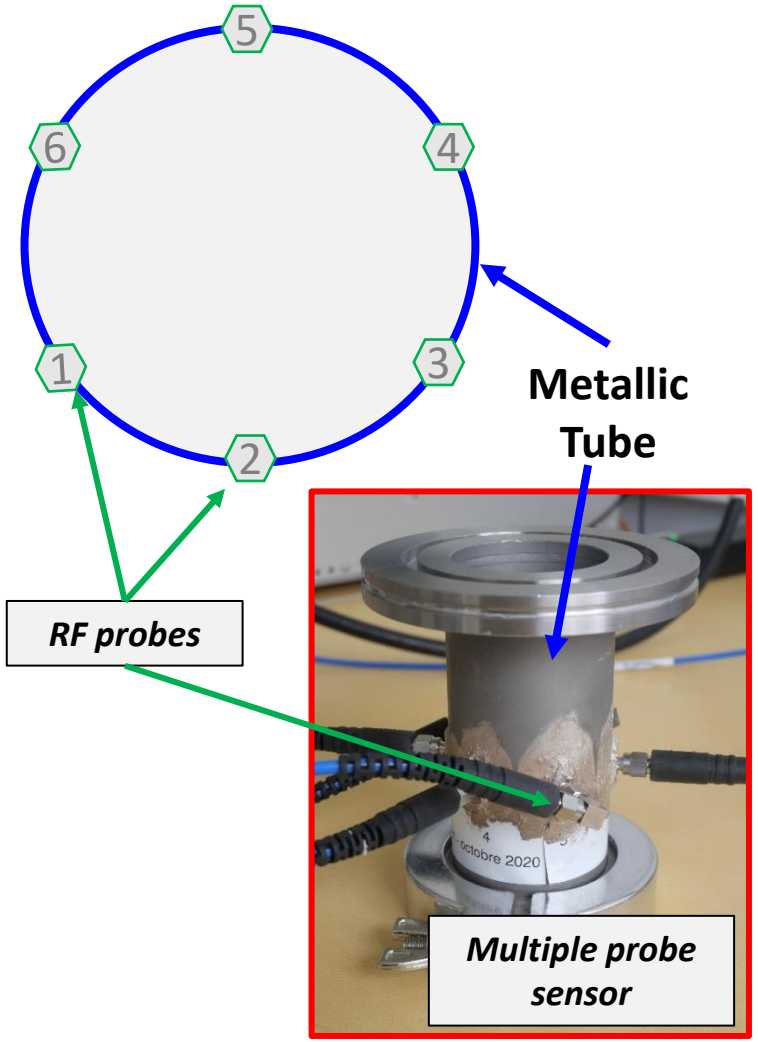
Lab moisture measurement:

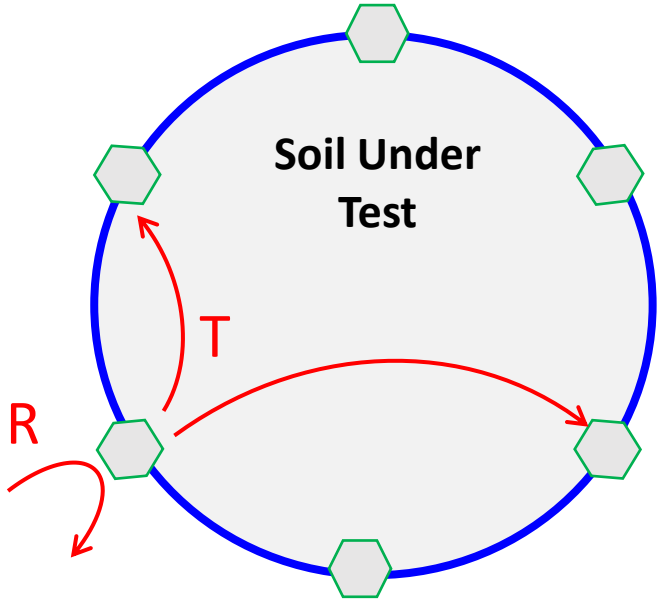
- **Dielectrically permittivity techniques** → Only samples



<u>Our objective</u>: → A new system using microwave probing to test samples and field moisture content measurements

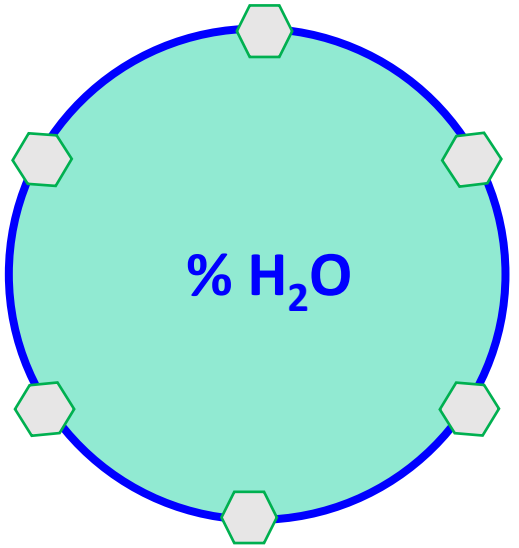
Architecture of the multiple probes sensor and main goal



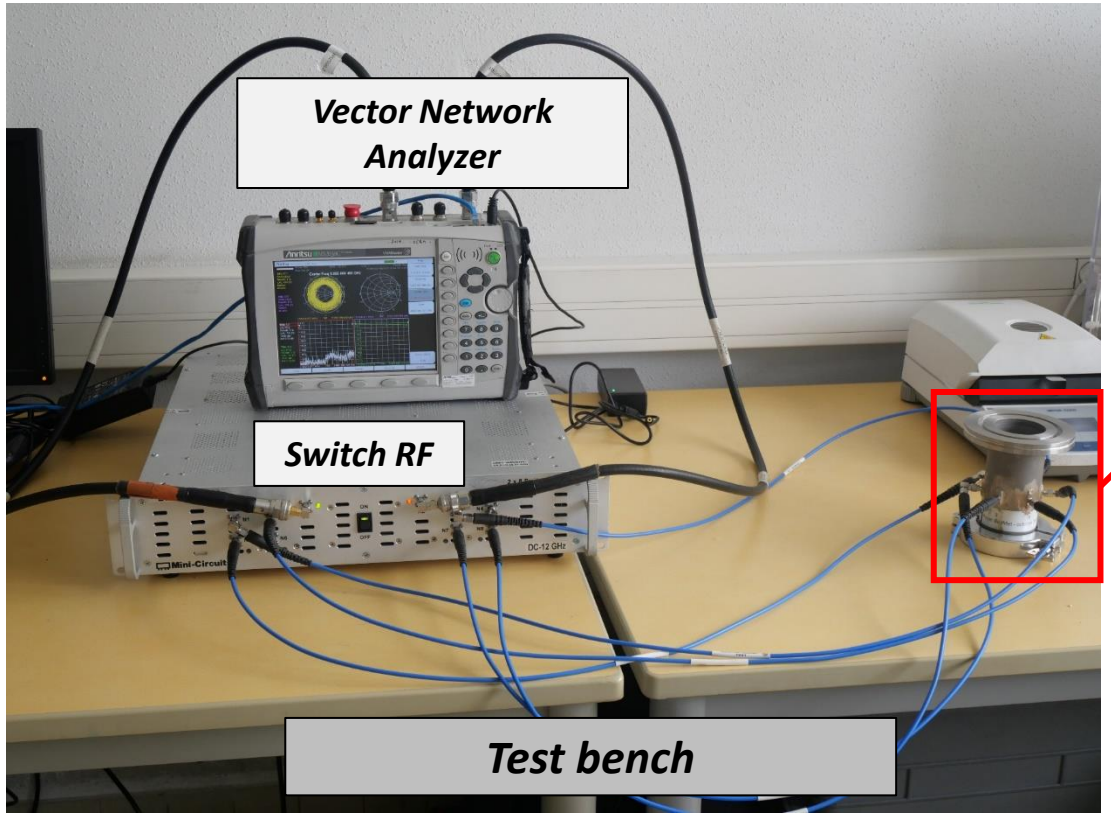


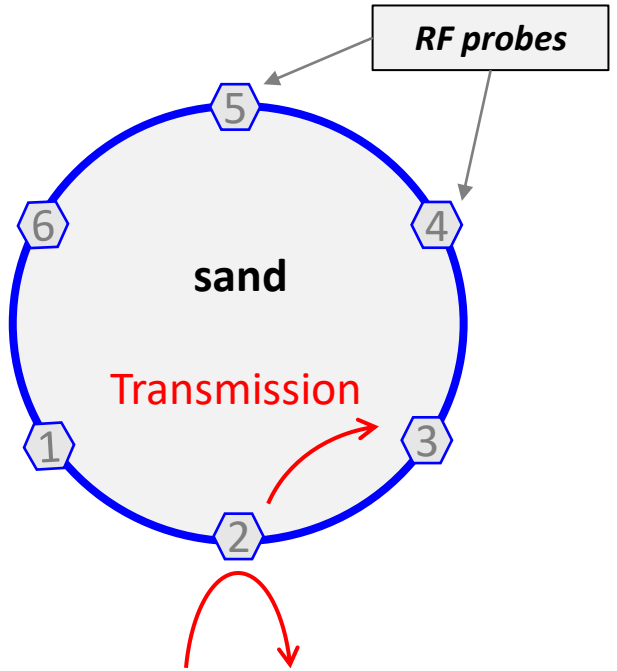
Reflection **R** (%MC) ?

Transmission **T** (%MC) ?



Test bench





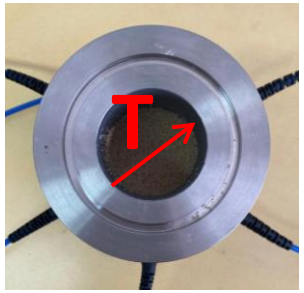
Development of a Python software

- ✓ Bench control
- ✓ Data acquisition
- ✓ Measurement protocol

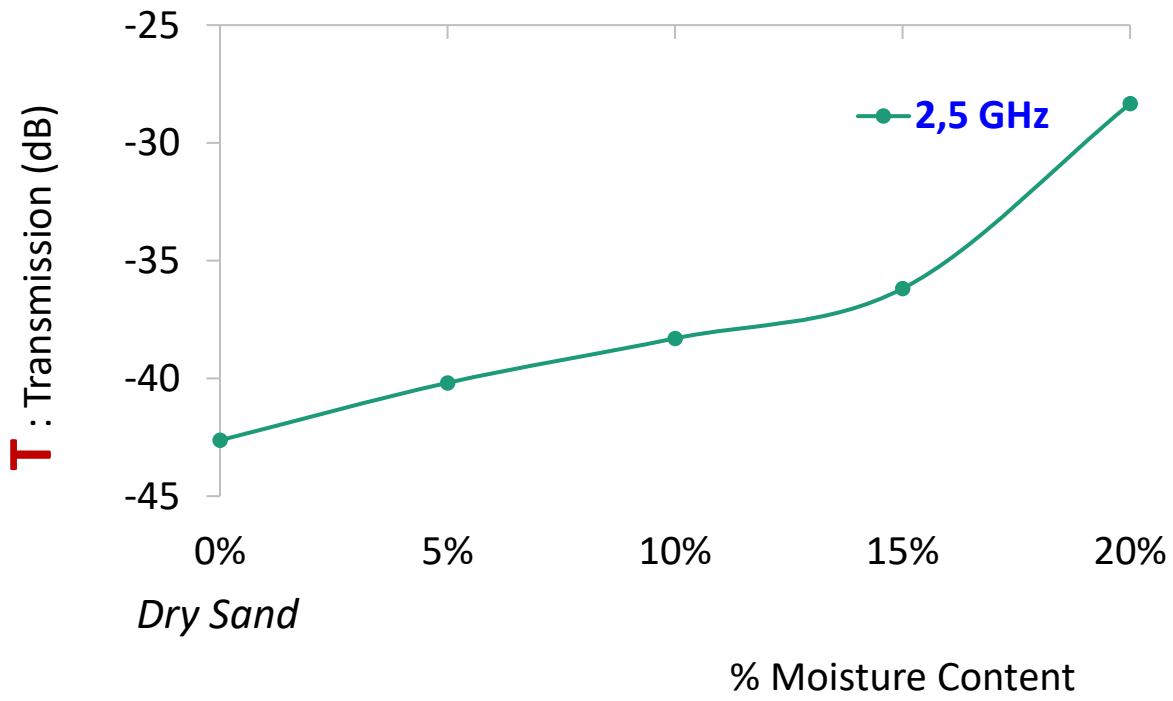
R (%MC) ?

T (%MC) ?

Results of mixtures of sand/water



*Transmission results with the **sensor***



T (%MC) ?

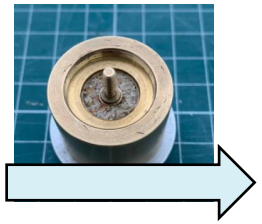
Dielectric proberties of sand

$\varepsilon_{water} \approx 80$

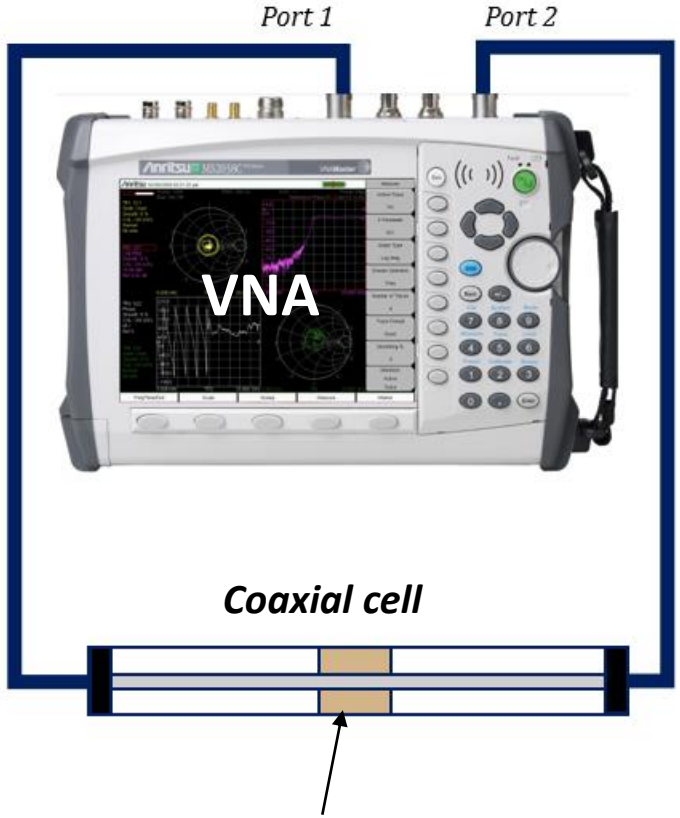
$\varepsilon_{dry\ sand} \approx 5$

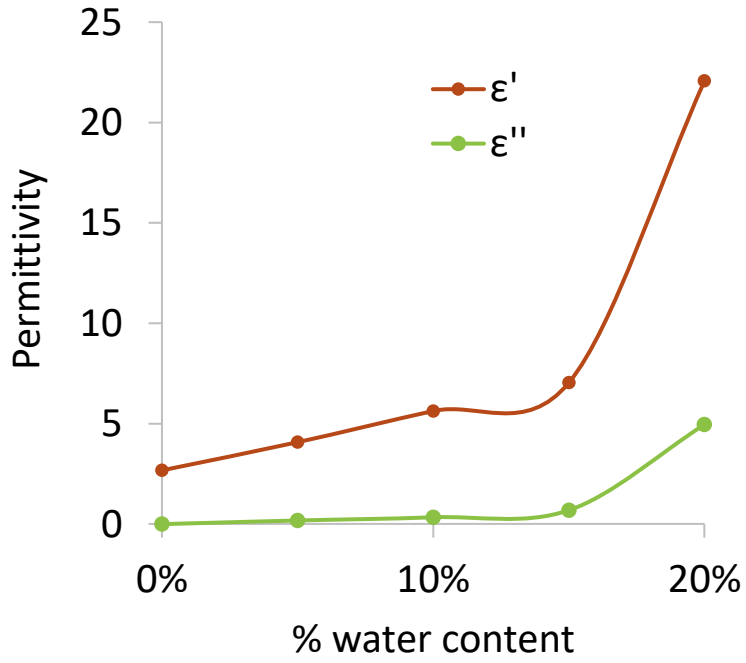
ε_{sand} (%water) ?

Material under test in sample holder



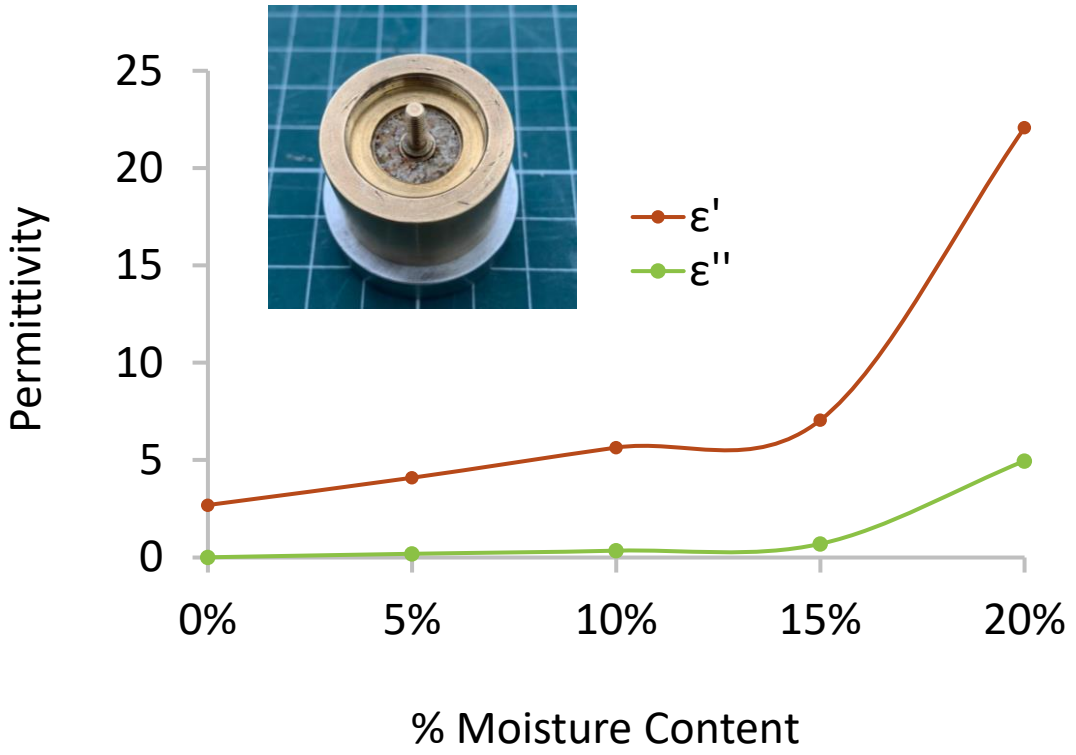
Verification of varation of ***permittivity ε*** with water content in sand



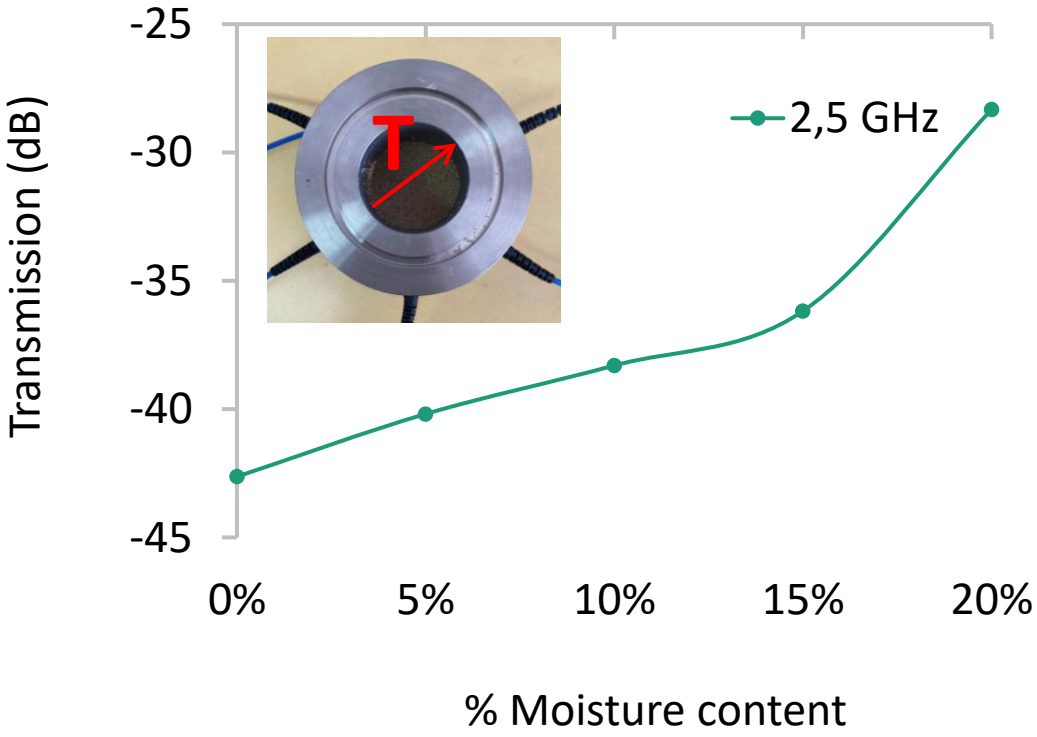


Results of mixtures of sand/water

*Variation of **dielectric measurements** at 2,5 GHz versus %MC*



*Transmission with the Multiple probe **sensor***



ε_{sand} (%MC) ⟺ T (%MC)

Conclusion

Main results :

Proof of concept:
Evaluation of **threshold** of moisture content in homogeneous soil with the multiple probe sensor : **5%**

Futur development:

- Characterization of realistic complex soils samples such as sand/clay/inclusions (gravel)
- Implementation of the multiple probe sensor in a core driller to measure water content in deep soils

Thank you for your attention